VOLUME XLI NUMBER 3 WHOLE NUMBER 362

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

EDITOR, C. A. CHANT ASSISTANT EDITOR, F. S. HOGG

David Dunlap Observatory
Richmond Hill P.O., Ont.

ASSOCIATE EDITORS:

C. S. BEALS
Acting Dominion Astronomer
Ottawa

J. A. PEARCE
Dominion Astro-physicist
Victoria, B.C.

A. THOMSON
Controller of the Meteorological Service of Canada, Toronto

PUBLISHED MONTHLY
(Ten numbers per year)

March, 1947

PRINTED FOR THE SOCIETY
TORONTO: 3 WILLCOCKS ST.

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

VOL. XLI, No. 3 MARCH, 1947 WHOLE No. 362

Articles PAGE

Atomic Energy ..... *A. E. Johns* 81

Annual General Meeting of the R.A.S.C.

Minutes of Meeting 97

Report of the General Secretary 99

Report of the Librarian 102

Reports of Secretaries of the Centres 104

Report of the General Treasurer 117

Reports of Treasurers of the Centres 120

Officers for 1947 124

Obituary

Allan Frederick Miller, 1851-1947 ..... *J. R. Collins* 127

Upon request, made previous to publication of article, contributors will be supplied free with twenty-five copies of the sheets containing the article attached to a printed cover.

Extra copies about as follows:

	4 pp.	8 pp.	12 pp.	16 pp.	20 pp.	24 pp.
50 copies	$3 50	$5 50	$9 50	$10 00	$13 00	$16 00
100 copies	4 00	7 00	10 00	11 00	14 00	18 00
200 copies	4 50	8 00	11 00	12 00	15 50	20 00

Covers, extra, 50 copies, $1.50; 100 copies, $2.00; 200 copies, $2.50.

Address of Editors: David Dunlap Observatory, Richmond Hill, Ontario.

Business correspondence, remittances, etc., should be addressed to J. H. Horning, Treasurer of the Society, 3 Willcocks St., Toronto 5, Ontario.

$2.00 per annum. Single numbers, 25 cents.

Subscription to the JOURNAL is included in membership fee.

NOTICE FROM THE GENERAL TREASURER

Those who have already received the OBSERVER'S HANDBOOK for 1947, but are intending to resign their membership at the end of 1946, are asked to send the 25c payment (coin in card) to their local treasurer or to the General Treasurer, 3 Willcocks St., Toronto 5.

PRINTED IN CANADA

THE JOURNAL
OF
THE ROYAL ASTRONOMICAL SOCIETY
OF CANADA

VOL. XLI, No. 3 MARCH 1947 WHOLE No. 362

ATOMIC ENERGY*

By A. E. JOHNS

Introduction

OUR topic for this evening is timely. Whether we are fully conscious of the fact or not and whether we like it or not, we stand at the opening of a new age—the atomic age, or the age of atomic energy. Atomic energy has always been present in the universe, but only now is it becoming available to man. The secrets of the atom are being unlocked before our eyes and life for mankind can never be the same.

Your presence here in such large numbers on such a rainy night indicates your interest in this topic. We are all interested and want to know the underlying principles of atomic energy. It is my hope that some of these will be more clear in an hour's time. But I warn you that I bring little that is new. Mark Antony's words at Caesar's funeral sum up the situation; "I am no orator, as Brutus is; . . . . . I only speak right on; I tell you that which you yourselves do know." The lecture will be in informal classroom style. Few teachers can proceed long without a blackboard; so I have already listed the topics I hope to treat and for two reasons. First it will help to guide me, and second it will comfort you. At any stage you can see how the lecture is progressing, and, when thoroughly bored, can say "That much at least is over." You note with pleasure that the 'Introduction' is already finished.

*Address of the Retiring President, Annual At-Home of R.A.S.C. at Toronto, January 24, 1947.

Foundation Theory

During the eighteenth century man discovered that great law, the Law of the Conservation of Matter. According to it, no matter is ever created or destroyed. The total amount of matter in the universe remains the same. True, matter may be changed in form. Water may be heated into steam or frozen into ice, but its mass remains constant. Matter may be shifted about in the universe. The moon may lose its atmosphere or a meteorite from the bounds of the solar system may fall at our feet, but the total amount of material in the universe remains the same. In any chemical action the final products weigh just as much as the constituents entering it. On one scale of a balance put the coal you throw into your furnace, and pile on, if you can, all the oxygen used in combustion. On the other scale put all the ashes, and all the smoke and gases resulting from the fire. The scales balance.

In the nineteenth century was stated another great law, the Law of the Conservation of Energy. No energy is ever created or destroyed. Its form changes, its amount is unaltered. The sun's energy in the form of light and heat comes racing down to us. It dries up (at least we hope it will to-morrow) our sodden streets. The water, lifted now into the clouds, has the potential energy of a raised weight. The winds carry it over Lake Erie and it falls as rain, losing some of its energy in heat, but it is still higher than the Niagara Gorge. It enters the turbines of the Ontario Hydro Electric Commission and its remaining energy is transformed into electrical energy and distributed at high voltage all over Ontario. It runs our street cars and lights our cities. It enters our homes, runs our washing machines, our radios, our refrigerators. It cooks our meals, toasts our bread and heats our bath water. It begins as heat, undergoes many transformations and ends up as heat. None is lost.

> Nothing of him that doth fade
> But doth suffer a sea-change
> Into something rich and strange

The twentieth century saw the two laws combined. In 1905 Einstein propounded his theory of relativity which has revolutionised all our thinking in the scientific realm ever since. He claimed that these two Conservation Laws are two aspects of one more

fundamental law, for matter and energy are just two manifestations of the same thing. Neither law taken alone is quite true, for matter can change into energy and energy into matter. Together they are absolute. "The total amount of matter and energy in the universe remains the same." He went further and wrote down from theory the equation

$$E = mc^2$$

connecting energy E and mass m. If m is given in grams and c is the velocity of light in centimetres per second, then E is given in ergs. Since, in these units $c = 3 \times 10^{10}$, this equation shows that a very small bit of matter will yield an enormous amount of energy. One kilogram (2.2 pounds) of matter, whether of coal or butter, if converted entirely into energy would yield 25 thousand million kilowatt hours of energy; thus

$$E = \frac{1000 \times 9 \times 10^{20}}{10^7 \times 3600 \times 10^3} = 25 \times 10^9.$$

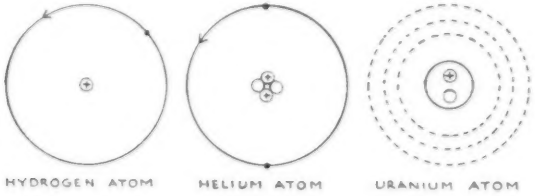
This is equal to the energy that would be generated by the total electric power industry in the United States (as of 1939) running for approximately two months. Burning this amount of coal would give us 8.5 kilowatt hours of heat energy, so that the ratio is about three thousand million to one. No wonder the tiny losses of matter could not be detected, and there was no confirmation of Einstein's prediction for 25 years, though he had suggested that radioactive substances should give it.

Theory of Atomic Structure

If we are to understand how atomic energy is released we must know something of atomic structure, and form some picture or construct some model of an atom. At dinner to-night Mrs. Johns remarked that the Chinese thought in pictures for theirs is a picture language. *One woman under a roof* is their ideogram for *peace*. That picture appeals to us; fundamentally we are all alike. Our models of the atom may not be wholly correct, but if they help our thinking, their creation is justified. We believe now that all atoms are in the main constructed out of three fundamental bricks, the electron, the proton and the neutron, and from these atoms the whole universe is built up. The electron or β-particle is very light

and exceedingly small, since fifty thousand million placed side by side would stretch across a period at the end of a sentence on a printed page. It carries a unit negative charge of electricity. The proton carries a unit positive charge of electricity, is smaller in volume than the electron but weighs 1,847 times as much. The neutron was discovered in 1932 by Chadwick in England, has a mass close to that of the proton and, as its name would indicate, carries no charge at all. This unique characteristic of neutrons delayed their discovery, prevents us from observing them directly, makes them very penetrating and so important in nuclear change.

From these three basic cosmic units, the 92 elements of chemistry are built and range from the lightest, hydrogen, to the heaviest, uranium. We conceive the atom as consisting of a central nucleus made up of an approximately equal number of protons and neutrons; and about the same number of electrons revolving as satellites around the nucleus. To be balanced electrically there must be just as many electrons carrying negative charges as protons carrying positive charges. This number is the atomic number of the atom. The total number of protons and neutrons in an atom is its atomic weight approximately and is called its mass number. Thus the hydrogen atom has one proton as nucleus, and one satellite electron.



So its atomic number is one and its mass number one. The helium atom has a nucleus consisting of two protons and two neutrons, and two satellite electrons. Its atomic number is two and its mass number four. Nature's heaviest atom has 92 protons and 146 neutrons for its nucleus, and 92 satellite electrons. Its atomic number is 92 and its mass number 238. This atom turns out to be the basic source of atomic energy.

Atoms themselves are also exceedingly small for the combined diameters of two hundred million of them would be an inch long.

Even at that they consist mostly of emptiness, for if the nucleus were enlarged to a baseball, the satellite electrons would be specks some 2,000 feet away. As we know, the solar system is also mostly empty. In round numbers for both the atom and the solar system the radius of the whole is 10,000 times the radius of the central sun. The analogy is striking.

The chemical properties of any substance are determined by the satellite electrons. In this sense then, chemistry is concerned only with the superstructure of the atoms, and never comes to grips with the nucleus. The 92 elements of chemistry have the 92 kinds of superstructure. Though the satellite electrons move at high speed their mass is negligible, so that the energy values involved are relatively small and chemical changes can yield but little energy.

Isotopes

An architect with only 92 house elevations could design many more than 92 interiors. Similarly nature assisted by man has designed upwards of 600 atoms despite the fact that only 92 exteriors seemed possible. This is accomplished by the addition to or subtraction from the nucleus, of neutrons, thus changing the mass number. These new atoms are called isotopes of the original and are chemically indistinguishable from them. Thus heavy hydrogen has one proton and one neutron in its nucleus and one satellite electron, so that it is almost twice as heavy as ordinary hydrogen, but has the same chemical properties. Heavy water is built up from heavy hydrogen and oxygen. It is very expensive and is used by the ton in the atomic energy plant at Chalk River. Natural carbon consists of 99 per cent. of ${}_6C^{12}$ and one per cent. of ${}_6C^{13}$, the former having as nucleus 6 protons and 6 neutrons and the latter 6 protons and 7 neutrons. The respective atomic weights are 12 and 13. Both are carbon with atomic number 6. Uranium as found in nature consists of three isotopes, a trace of U^{234} with 142 neutrons, 0.7 per cent. of U^{235} with 143 neutrons, and 99.3 per cent. of U^{238} with 146 neutrons. It turns out that the valuable one for securing the release of atomic energy is U^{235}, but it is found mixed with 139 parts of U^{238}. If the proportion in nature had been reversed, the Germans would have won the war.

Atomic Energy Released by Nature

We have seen that chemical actions, which are always concerned with the superstructure of the atom, yield comparatively little energy. To secure larger amounts the nucleus of the atom must be invaded. I shall cite two illustrations of such energy release which is going on in nature.

The first is radioactivity. It has been known for about fifty years that the element radium is continuously shooting out projectiles at terrific speeds. Such emanations are of three types, α-particles which are the nuclei of helium atoms, β-particles or electrons and γ-rays which are similar to x-rays. By a series of transformations an atom of radium ${}_{88}Ra^{226}$ with mass number 226 and atomic number 88 gives off, besides γ-rays, five α-particles and four β-particles to become an atom of lead, ${}_{82}Pb^{206}$, with mass number 206 and atomic number 82. The mass numbers check, since each helium atom has a mass number of four and $5 \times 4 = 20$ is the loss in mass number. The atomic numbers also check, since $5 \times 2 = 10$ units of positive charge are lost with the 5 α-particles, and 4 unit negative charges with the 4 electrons—a net loss of 6 units of positive charge from the nucleus. Radium is being transformed into lead before our eyes. In about 1600 years half our radium will be so transformed. In another 1600 years half of what remained and so on. Hence we speak of the half-life of radium as 1600 years. Always some radium will remain.

Our second illustration is of special interest to the astronomer. We are told that the sun in every second of time is giving out 10^{20} kilowatt hours of energy and has been doing this for some 10^9 or 10^{10} years. Using Einstein's equation $E = m c^2$, we find that this is equivalent to the transformation of 250 million tons of matter into energy every minute over this tremendous span of time. Professor Bethe of Cornell suggests that the source of this energy is atomic and gives us the following 'carbon cycle' of nuclear reactions.

$$
\begin{aligned}
{}_6C^{12} + {}_1H^1 &\longrightarrow {}_7N^{13} + \gamma \\
{}_7N^{13} &\longrightarrow {}_6C^{13} + {}_1e^0 \\
{}_6C^{13} + {}_1H^1 &\longrightarrow {}_7N^{14} + \gamma \\
{}_7N^{14} + {}_1H^1 &\longrightarrow {}_8O^{15} + \gamma \\
{}_8O^{15} &\longrightarrow {}_7N^{15} + {}_1e^0 \\
{}_7N^{15} + {}_1H^1 &\longrightarrow {}_6C^{12} + {}_2He^4
\end{aligned}
$$

In this cycle enter one isotope of oxygen, three of nitrogen and two of carbon. The net result of the cycle is to leave the carbon unchanged, emit 3 γ-rays and 2 positrons, ${}_{1}e^{0}$, (the counterpart of the electron with a unit positive charge), and convert four atoms of hydrogen into one atom of helium. Now the mass of 4 atoms of hydrogen is 4.032 units while that of 1 atom of helium is 4.004. The difference of 0.028 units, which amounts to about 7/10 of one per cent. of the original, has been transformed into energy. The late Sir James Jeans made this statement, "A sun in which only one-fifth of one per cent. was hydrogen could provide the present sun's radiation for 2,000 million years, and it is fairly certain that the sun contains more hydrogen than this."*

Atomic Energy Released by Man—Fission

For the splitting of an atom man has at his disposal some very high power projectiles in the form of neutrons, deuterons, protons, α-particles, γ-rays and rarely heavy particles. It is difficult to hit the nucleus of an atom with a charged particle, since either the sheltering cloud of electrons or the repulsive force of the nucleus will turn the missile aside. But neutrons, having no charge, can be deflected only by a direct collision and so are most effective as atom smashers. Using neutrons men began bombarding all the elements, and it was found that in general the nucleus absorbed the neutron, achieved stability by emitting an electron and formed a nucleus with atomic number and mass number each one higher than the original. It was natural to investigate what would happen when uranium, the heaviest element, was bombarded with neutrons. Late in 1938 O. Hahn of Germany (who in 1945 was given the Nobel Prize), showed that the heavy uranium nucleus was broken and that one of the fission products was barium. Extensive experiments in both Europe and America had by June, 1939, confirmed this atomic fission.† Here I only mention three of the many then known facts, but will amplify them later.

*For details I commend to you the book "Atomic Artillery and the Atomic Bomb," written by my old friend and classmate, Professor J. K. Robertson of Queen's University. I am indebted to him for some of these ideas and even some of the phrasing.

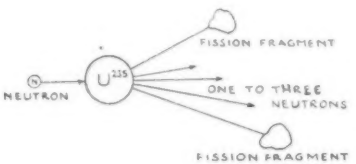
†For details I commend to your study Smyth's book, "Atomic Energy for Military Purposes."

(1) The products of the atomic fission were two unequal fragments near the middle of the table of atoms, for example, barium and krypton.

(2) Tremendous amounts of energy were given off in the process.

(3) From each atomic fission caused by one neutron, one to three neutrons arose.

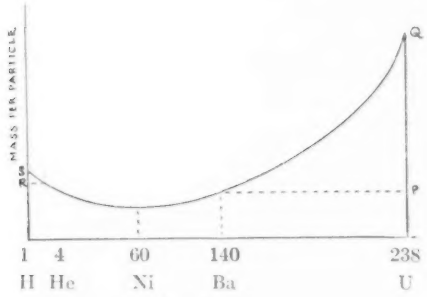
Graphically the fission may be indicated thus



Here then was something new under the sun. Atomic fission was a fact. The atom had been split. Then the black curtain of war descended on the world and split the scientists also into isolated groups.

The Mass-Defect Curve—Binding Energy

Let us return for a moment to the two illustrations cited of the release of atomic energy in nature, namely, radioactivity and the carbon cycle. It seems remarkable that energy can be released either by the breaking down of the more complex radium atom to the less complex lead atom or by the building up of the more complex helium atom from the less complex hydrogen atom. That both processes yield energy is possible because of the nature of the 92 elements themselves. It is a fact that the mass per particle (neutron or proton) in the nucleus is greater for either the very light or the very heavy elements than it is for the elements midway between. Hence when hydrogen is transformed to helium or uranium to barium, mass is lost and it appears as energy released. A graphic picture of what happens may be made thus:



The mass lost in the change from uranium to barium represented by PQ is 100 times the mass lost in the change from hydrogen to helium represented by RS.

The same facts may be stated in terms of energy. The 'binding energy' of a nucleus is defined to be the difference between the sum of the masses of all the protons and neutrons which went into its composition and the true nuclear mass. Thus the elements in the middle of the periodic table have the greatest binding energy or are most strongly bound. To break them up energy would have to be supplied; but when atoms of elements near either end of the table are transformed, energy is released.

A Chain Reaction

Ordinary combustion is an illustration of a chain reaction. We light a match. It sets fire to some paper. This ignites the kindling next it. This in turn, we hope, will ignite the coal. It is self sustaining. The fact that more than one neutron came out as a fission product, when only one caused the fission of U^{235}, suggested the possibility of a chain reaction, but no one knew whether or not it would work. If from one neutron came three, from three, nine, from nine, twenty-seven, the reaction would expand at a terrific rate. But it should be remembered that it is the rare isotope U^{235} which is broken by the neutron, and this occurs in nature mixed with 139 times as much U^{238}. So at least four things could happen to the emitted neutrons. They might (1) escape, (2) be captured by U^{238} without fission, (3) be absorbed by impurities, (4) cause fission

of another U^{235} nucleus. To get a chain reaction the number of neutrons in (4) decreased by the sum of those in (1), (2) and (3) must at least equal the original number put in. The first three possibilities must then be reduced to a minimum. The first loss was easily handled by making the pile of uranium being treated large enough. When the edge of a cube is tripled in length, the surface is increased nine fold, but the volume is increased twenty-seven fold. So the chance of escape through the surface per unit volume is much less than it was before. From theoretical considerations Fermi calculated how large, under attainable conditions, the pile should be and it worked—a marvelous achievement. Losses (2) and (3) were much more difficult to reduce to a minimum. Only the tremendous resources of the United States could make possible their solution, and a billion dollar plant was built at Oak Ridge, Tennessee. Since U^{235} and U^{238} are chemically indistinguishable they must be separated by physical means from the fact that U^{238} is the slightly heavier of the two. Thermal diffusion would separate the lighter fluid, U^{235}, just as our mothers got the lighter Devonshire cream on a pan of milk. Gaseous diffusion through barriers allowed the lighter U^{235} gas to pass more readily. The cream separator trick of the centrifuge brought the lighter U^{235} to the centre and a huge electromagnet could deflect lighter ions more than the heavier ones. Since some substances, for example, cadmium, soak up neutrons like a sponge, the problem of securing pure materials was also a formidable one. However these difficulties were sufficiently overcome and a pile was built in the squash court in Staff Field at the University of Chicago. Cadmium rods were inserted as safety devices and on December 2, 1942, the first self-maintaining nuclear chain reaction was initiated by man, even with the cadmium rods only partly withdrawn. For the well-being of Chicago the pile was torn down and moved to the Argonne Woods, some 40 miles outside Chicago. It should be noted that there are always enough stray neutrons about to start the chain reaction, so that no 'match' is required.

Moderators

It was early suggested by Fermi, Compton and others that slow neutrons, that is thermal or low energy neutrons, could be

used to split U^{235} and that such might not be absorbed by U^{238}. Since the neutrons coming out of the fission are always moving at high speed, a search was begun for so called 'moderators' which would slow up such neutrons before they were absorbed by U^{238}. If such could be found, the separation of U^{235} from U^{238} might not be necessary. Now fast neutrons are hard to stop, for they can pierce several inches of steel and about three feet of concrete, and yet the only way to stop them is to put something in their way. A tennis ball rebounds from the hard court with its velocity only slightly lessened, but if it collides head on with another tennis ball, its energy is passed on to the other and it stops dead. At each collision with a ball heavier than itself part of its energy would be given up. So moderators must have nuclei with masses comparable to the mass of the neutron, if the neutron is to be slowed up at each collision. Also to be useful it must itself not absorb neutrons. The substances with both these characteristics turned out to be carbon and heavy water, and both had to be of high purity. In the first pile at Chicago carbon was used, while at Chalk River heavy water is the moderator. This heavy water was made at Trail, B.C., tested at McMaster University and used at Chalk River.

Man-Made Elements

When a slow neutron is absorbed by a nucleus of U^{238} a nucleus of an unstable isotope, U^{239}, is formed. Its half-life is only 23 minutes and from its disintegration a new element, neptunium, with atomic number 93 and mass number 239 is formed. This new element also is unstable with a half-life of 2.3 days and disintegrates to form a second new element, plutonium with atomic number 94 and mass number 239. The reactions are

$$_{92}U^{238} + {}_{0}n^{1} \xrightarrow{\text{slow}} {}_{92}U^{239} + \gamma$$

$$_{92}U^{239} \xrightarrow[23\text{ minutes.}]{} {}_{93}Np^{239} + {}_{-1}e^{0} + \gamma$$

$$_{93}Np^{239} \xrightarrow[2.3\text{ days}]{} {}_{94}Pu^{239} + {}_{-1}e^{0} + \gamma.$$

This isotope $_{94}Pu^{239}$ of plutonium does slowly decay by the emission of an α-particle to $_{92}U^{235}$, but its half-life is 24,000 years, so that it is

really very stable. Recently the discovery of two more man-made elements has been announced. Since the astronomers in their search of planets beyond Pluto have not kept pace with the discovery of elements beyond plutonium, it is proposed to call these two elements americium and curium respectively, in honour of the Americas and of Pierre and Marie Curie.

Plutonium has qualities which make it so tremendously important that it is largely replacing U^{235} in both military and peace-time applications. Though usually stable, it is fissionable by slow neutrons just as U^{235}. It is potentially more abundant since it is created from the much more plentiful U^{238}. It is a different element from uranium and hence can be separated from it by chemical means. So the atomic energy plant using uranium is allowed to run several months after which the uranium rods are removed and the plutonium created in them is separated out. It is like hunting a needle in a haystack, for 50 kilograms of uranium may have 10 grams of plutonium in it.

Fission Products

I have already remarked that the kinds of atoms now discovered number upwards of 600, and of these a very large number, well over 200, have arisen as fission products by neutron bombardment of uranium. These fission products range all the way from zinc to samarium. Strangely enough they break into two groups. The light group consists of those from zinc with mass number about 72 to palladium with mass number about 108, and shows the greatest concentration around krypton with mass number 94. The heavy group goes from palladium to samarium with mass number 150 and shows the greatest concentration around barium with mass number 140. Actually about 6 per cent. is krypton and 6 per cent. barium, with 97 per cent. of all fission products grouped closely around these. The minimum is around tin with mass number 117 and the yield there is about 0.01 per cent. of the whole.

For the lighter elements in the periodic table the number of neutrons in the nucleus is about equal to the number of protons. For instance carbon has six of each. But as we ascend in the table the proportion of neutrons to protons gradually increases until in

uranium 238 there are 146 neutrons to 92 protons. So the fission products from uranium, which are near the middle of the table, are overloaded with neutrons and are likely to be unstable and give off β-rays in succession until a stable product is formed. There are 64 such mass chains of transformations now known, 31 in the light group and 33 in the heavy and they involve about 164 known active products, and about 64 stable ones. McMaster University, under Dr. Thode's direction, is given credit for the discovery of 8 of the stable products, and 1 active one, namely, Kr^{85} with a half-life of 10 years.

The problems presented to the chemist by these fission products were appalling. He had to separate the minute quantities of these bewildering products from the original uranium and the neptunium and plutonium created there as well. He had to determine what elements were there and what isotope. If the product was radio-active, what was its half-life, was it formed directly or was it part of a chain, and if of a chain how was it related to other fission products? What energy had the β- and γ-rays emitted? These and many other questions confronted the chemist, and he had to work with exceedingly minute quantities and he had to work fast. Any product with half-life of less than 2 seconds cannot yet be identified. One instrument, the mass spectrometer, has been his powerful ally. By it he 'scans' the fission products and obtains results of surprising accuracy.

Industrial Applications of Atomic Energy

The energy released in atomic fission is tremendous. From the smashing of a single uranium nucleus come some 160 million electron volts. (An electron volt is the energy acquired by an electron in moving through a potential difference of 1 volt.) Chemical action might yield 2 or 3 electron volts. The fission of one pound of U^{235} would yield 11,400,000 kilowatt hours of energy.

Is it any wonder then that an atomic bomb can do such terrible damage? At 8.17 a.m. on August 5, 1945, there was a blinding flash in Hiroshima—a piece of the sun instantaneously created. All buildings within a radius of two miles were completely destroyed, roofs were off at five miles and glass broken 12 miles away, 95,000 people were killed or missing and 140,000 more injured.

Of 600 girls from a Protestant girls' school who were scattered over the city, 30 to 40 later returned. The falling roof pinned 50 of those at school under it and they were burned before the eyes of their principal. Such a bomb dropped on the campus of the University of Toronto would wipe out everything from St. Clair to the Lake, and from the Don half way to High Park, and glass would be broken in Port Credit. In a twinkling one-quarter of the population of Greater Toronto would be killed or injured. And now they can make bombs 1,000 times as powerful as that.

But atomic energy could be and we trust will be a marvelous blessing. Already estimates would indicate that atomic energy plants can deliver energy at 0.8 cents per kilowatt hour. (We pay 0.7 cents for domestic use in Hamilton.) We cannot expect it to power our automobiles. The critical size of a pile to get any power at all, and the tons of steel and concrete necessary to protect us from those penetrating radiations, prevent us from just putting a gram of plutonium in our car and running it for a life-time. But such a pile could power an Atlantic Liner, and it could provide power in parts of the world where there is neither coal nor hydro.

Recently at McMaster I heard a fine address on Canadian Population Trends by an authority. In all his prognosis the speaker was careful to put in a qualifying "all conditions being the same." I recalled a jocular remark made in an after dinner speech by my old Professor, the late Alfred Baker. "It is customary for great men at some time in their lives to make a prophecy. I will make mine now. I predict that in 500 years the centre of civilization will be in the Saskatchewan Valley." So in the question period I asked the speaker if that were possible. He did not think so. Industrial concentration was unlikely in a land where there was no iron and only poor grade coal. Dr. Thode then rose to say that conditions were not the same. The atomic age had arrived. Power plants can as well be built in Saskatchewan as in Hamilton. Who can predict the industrial future of our Canadian West in this new age?

Atomic Energy in Medicine

It was recognized at once that the wealth of radioactive fission products made available in quantity by atomic energy plants had opened up great new possibilities in medicine. The half-life of

some of these is long enough to make them useful. Phosphorus, P^{32} has a half-life of 14.3 days. Iodine, I^{131} has a half-life of 8 days. Treatment by radium may be completely superceded by the use of such new products as these.

They can be used as tracers. Radioactive sodium, Na^{24} injected into the blood stream in one hand reaches the other hand in 20 seconds. If taken internally it reaches the finger tips in 2 or 3 minutes. Radioactive carbon, C^{14} may help us to understand the whole process of metabolism. Some scientists claim that its production may well be with all the money spent on atomic fission. Its half-life is about 10,000 years.

Iodine, I^{131} if taken into the human system heads for the thyroid gland, as does ordinary iodine. Can cancer of the thyroid be cured by letting iodine, I^{131} seek out its prey? Radioactive phosphorus, P^{32} concentrates in the spleen and liver, so that large doses can be given these organs. Already this isotope has given spectacular results in the treatment of polythemia vera, a sort of cancer of the red corpuscles. But here, as always, must follow an immense amount of investigation of just how each fission product acts on human tissue, what human enemy does it attack and what is the proper dose that will kill this enemy and not unduly injure healthy tissue. We are just entering the Promised Land—the Atomic Energy Age.

Chalk River

I had hoped to speak briefly on our Canadian atomic energy plant at Chalk River, which I visited last summer. However this lecture is already too long so that my remarks on this topic must be very sketchy.

This site, half way between North Bay and Ottawa, on the Ottawa river, was chosen because it had three main qualifications. It had an ample supply of pure water, it was accessible for bringing in heavy machinery, and it was not near large centres of population in case of accident. In less than three years huge buildings have been erected and these are carefully guarded. In order to gain entrance, one has to lay plans some weeks in advance, be fingerprinted, have his past history checked, and declare that he will not sell out to the enemy. Inside is the sign, "What you see here, what you hear here, stays here when you leave here." In some

respects it is almost like a university, for there were lectures almost daily, as each department tried to keep the others informed of its latest discovery. Everywhere the greatest precautions are taken for safeguarding the health of the workers and visitors. In certain buildings cloth shoes and coats are provided, to insure that we did not inadvertantly pick up some radioactive particle, which might cause a burn. The chemists watched their experiments through periscopes. No work is being done on atomic bombs, but important investigations in industrial and medical applications of atomic energy are under way. I found it a stimulating, almost an exciting place, to visit.

The workers at the Chalk River plant are housed in a town site, Deep River, twelve miles by bus up the Ottawa River. This, too, had a guard house at its entrance. Three years ago the site was just sand with a light stand of evergreen and birch. Bulldozers ripped out the streets, sidewalks went down, some 400 houses went up, and now behold a town of some 2,000 people. A staff house shelters and feeds about 200 workers and guests. There is a general store, a five-room public school, a hospital with plenty of maternity cases, a recreation centre and a church being organized. Some twenty clubs, camera, chess, skiing, etc., flourish. It is a young people's town. The number of academic degrees held by its inhabitants per capita is probably the highest in Canada.

Conclusion

I conclude with the following quotation from the Presidential Address to the British Association delivered in 1934 by the late Sir James Jeans. "Science has given man control over nature before he has gained control over himself. The tragedy does not lie in man having so much scientific control over nature, but in his having so little control over himself. Human nature changes very slowly and so forever lags behind human knowledge which accumulates very rapidly. Scientific knowledge is transmitted from one generation to another while acquired characteristics are not. Thus in respect of knowledge each generation stands on the shoulders of its predecessor, but in respect of human nature both stand on the same ground."

McMaster University,
Hamilton, Ontario.

MINUTES OF THE ANNUAL MEETING OF THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

THE fifty-seventh annual meeting was held in the McLennan Laboratory, Toronto, on Friday, January 17th, 1947. Dr. Johns, the President, occupied the chair.

The minutes of the last annual meeting having been published in the JOURNAL, were taken as read and adopted.

Scrutineers. Miss Budd and Mr. Crook were appointed scrutineers and were allowed to retire for the counting of the ballots.

General Secretary's Report. Mr. E. J. A. Kennedy, General Secretary, referred first to the reports received from the various centres, which were encouraging and which showed an increase in membership from 1135 to 1243. In addition to the members of the centres, there are 359 unattached members, making a total of 1602 at the end of 1946. No award of the Chant medal was made in 1946. One application was received too late for consideration, but this will be taken up in 1947. Honorary Members—The Council recommended for Honorary Membership as follows:

Sir Harold Spencer Jones, M.A., Sc.D., F.G.S., Astronomer Royal, London, and Dr. Harlow Shapley, Director Harvard College Observatory, Cambridge, Mass. It was moved, seconded and carried, that the recommendation be approved.

The General Secretary's report was adopted, and passed on for publication in the JOURNAL.

General Treasurer's Report. Before entering upon the details of his report, Mr. J. H. Horning, General Treasurer, referred to a donation of $100 received during the year from the Toronto Centre, and on motion, duly seconded and carried, the thanks of the Society were expressed for this gift. Mr. Horning also expressed the hope that the Dominion Government would grant our request and raise the annual grant to the Society to $3,000. The financial statement showed receipts for the year 1946 (including balance of $964.46 from the previous year and $500 borrowed from the Building Fund) to be $8,381.95. The expenditures were $6,374.10, with outstanding accounts (in addition to the $500 loan) of $1,679.31. Details and explanatory information will be found in the JOURNAL.

The General Treasurer's report was adopted.

Provincial Grants. On motion of Mr. Andrew Thomson, seconded by Mr. J. H. Horning, it was agreed to encourage the various centres to ask for provincial grants toward the support of their own work.

Librarian's Report. Dr. D. W. Best, Librarian, reported that the number of periodicals received from Canada and the Empire was 46, from the United States 65, and from other countries 38. 201 books had been loaned. Due to financial stringency no new books were purchased, the only expenditure being $36.94 for binding.

On motion of Mr. Horning and Mr. Kennedy, authorization was given for an expenditure up to $25.00 for new books.

References to the Council. The following matters were referred to the General Council for consideration and action: (1) Division of the office space and the question of sub-letting part of it: (2) Additional office assistance: (3) Office telephone: (4) Changing date of fiscal year.

Editing Committee. Dr. F. S. Hogg, in the absence of Dr. Chant, gave a verbal report for the Editing Committee. Every effort was made during the year to keep down expenses. This is difficult, however, in view of the advancing cost of paper and printing. Two issues were bound within one cover, and the total number of pages has been lessened.

Thanks. On motion of Mr. G. T. Dale, seconded by Mr. C. A. Crook, the thanks and appreciation of the Society were conveyed to Dr. Chant, Dr. Hogg and their associates, for their valuable services in connection with the publications; and also to the other officers of the Society for carrying through their onerous duties so acceptably.

Attendance. Mr. F. L. Troyer referred to the small attendance at the annual meeting each year, and expressed the hope that in future greater emphasis should be laid on the importance of the meetings with the intimation that all members will be welcomed.

Death of Mr. Collier. Mr. J. R. Collins announced the recent demise of Mr. H. B. Collier who for many years in the past was a prominent and most valuable member of the Society.

Scrutineers' Report. The scrutineers reported that 232 ballots had been received, and that those nominated by the council and various centres had been duly elected.

Editor and Assistant Editor. It was unanimously agreed that when the Editor cannot be present at General Council meetings, the Assistant Editor should take his place on that Board.

The meeting then adjourned.

H. W. BARKER, *Recorder.*

REPORT OF THE GENERAL SECRETARY

It can be definitely stated that the Royal Astronomical Society of Canada is filling an increasingly important part in the scientific and cultural life of the Dominion. A reading of the reports of the secretaries of the centres across Canada amply justifies this statement. Besides the regular meetings during the season to stimulate the public interest in astronomy some of the centres are sponsoring courses of instruction in observing. These classes particularly in Montreal and Victoria are well attended: activities of this character possess possibilities of making valuable scientific additions to our knowledge of the universe. These two centres are fortunate in each having an observatory supported by members, at their disposal; they are also well equipped with telescopes. Montreal has built up a splendid organization for observing and then collating all their data. Their programme includes observations of variable stars, sun-spots, meteors and aurorae. Reports are placed on file, and copies sent to the A.A.V.S.O., Harvard College Observatory and to Dr. Gartlein of Cornell.

Other centres report increased interest and activity, and I believe 1946 shows greater progress than any year heretofore. Our two-year-old centre, Windsor, reports interestedly of its co-operation with and help received from the Detroit Astronomical Society.

Telescope-making among members has been an important recent development. Toronto reports a group of 50, meeting at intervals for instruction and mutual help with Raymond Pearce as leader.

The Society is exceedingly fortunate in having the generous support and co-operation of all the professional astronomers across Canada, who contribute their time and talents so willingly; special thanks is due to the contributors of the Handbook and to Dr. Chant and Dr. F. S. Hogg, the editors. Their task increases each year with the growth of the Society.

The demand for the Observer's Handbook continues: 4600 were sold in 1946, and there were still unfilled orders; 5100 have been ordered for 1947; no doubt they will all be used.

Attached is a list showing the membership at the commencement of 1947: it shows an increase of about 12 per cent. over 1946. The total is 1602, last year 1425. It is to be noted that the new members are almost all in Canada; last year the great majority making up our increase were from abroad.

No award of the Chant Medal for 1946 can be made. Two names have been suggested—one nomination with the data to support it came in too late for the judges to make their decision; it is therefore held over until 1947. The officers of the centres are urged to publicize this worthy project at their meetings early in the season. The nominations have to be in the secretary's hands by the 31st of October to receive attention the same year. The judges are the directors of the four observatories, and time is necessary for them to make their decision. During the year our finances have become a matter of much concern—the General Treasurer, Mr. Horning, called the attention of the council in a special meeting, to the progressive increase in expenses over income; this increase is a natural result of our growing membership, to whom we give in our publications much greater value than the one dollar share of the fee which the treasurer retains. To this is added the great increase in the rent of our office and library. The grant received from the government which was given years ago to cover the expense of publications when the membership was less than one-third of the number now has become quite inadequate. Many suggestions came to us in the form of a questionnaire sent out to members of council. The consensus of opinion, however, was to first present our claim to the Government for an increase of our grant. This has been done emphasizing the great value in services the Society is rendering to Canada as a whole. Mr. Horning, in his literature to the Finance Minister and the Members of Parliament has enlarged on this point and we are hoping for a generous response. The amount requested is $3000. The shortage of money shows up also in the lack of attention to details and correspondence in the general office, more equipment and clerical help is needed to do a 100 per cent. job.

The office and library are now located at 3 Willcocks St.; the premises are a great improvement over our old quarters on College St. There is a room now for those who wish to come and use the library in quiet and comfort.

All the secretaries, except one, have sent in their reports. This is an improvement over previous years, it would be a pleasure to report that 100 per cent. had reported before the Annual Meeting.

The committee to appoint Honorary Members nominated Sir Harold Spencer Jones and Professor Harlow Shapley. These nominations were accepted at the Annual Meeting. The report of the committee follows:

Sir Harold Spencer Jones is the Astronomer Royal of Great Britain, directing the activities of the Royal Observatory at Greenwich, and the Nautical Almanac Office. In this position Sir Harold has inherited and upheld the finest traditions of such distinguished predecessors as Flamsteed, Halley, Airy and Dyson.

One of Sir Harold's great achievements was in connection with organizing and directing the program of international co-operation for the observations of Eros in 1930-31. Twenty-five observatories carried out this work, and from it Sir Harold derived the most accurate measure of the sun's distance, the fundamental unit of distance in astronomy. He has also contributed much in the fields of accurate time determination and distribution, of stellar parallaxes, and of solar eclipses.

During the difficult war years Sir Harold had the added problems of decentralization of the Observatory and Almanac work. At the present time he is engaged in the tradition-breaking, but very necessary, transfer of the "Greenwich" Observatory to a more favourable site outside London. This progressive step includes great expansion of Britain's Royal Observatory.

Professor Harlow Shapley has just completed his twenty-fifth year as Director of the Harvard Observatory. During this quarter of a century under Dr. Shapley's dynamic leadership the Observatory's expansion, inaugurated by Pickering, continued and accelerated, until now Harvard has fine branch observatories in South Africa, Colorado, and Oak Ridge, Massachusetts, as well as co-operative arrangements with a number of observatories in different lands. At Cambridge Dr. Shapley organized a large and active graduate school of astronomy, which has sent out astronomers to many observatories and universities.

Dr. Shapley's personal astronomical researches have always been on a magnificent and inspiring scale. From his critical determination of the orbital elements of ninety eclipsing binary stars at Princeton in 1912 through his series of Mount Wilson papers on variable stars and globular clusters, to his later Harvard work on most fields out to and including extra-galactic nebulae, his research has been epoch-making.

Not only in astronomy, but in other sciences, Dr. Shapley has been outstanding. His honours have been the highest that American and foreign societies, universities and governments could award.

Always an internationalist, in recent years he has spent much time and energy on the problems of world-wide science culture and peace.

Membership On December 31, 1946

	1945	1946
Toronto Centre	247	273
Montreal "	253	290
Winnipeg "	60	35
London "	43	37
Edmonton "	54	51
Hamilton "	41	51
Vancouver "	47	66
Ottawa "	45	65
Victoria "	110	119
Quebec "	75	88
Windsor "	45	59
Members unattached to Centres		
in Canada	105	109
in the United States	300	312
in other countries		23
Life Members who are not included in Centres		24
	1429	1602
Additional Subscribers to Journal	52	62

E. J. A. Kennedy, *General Secretary.*

Librarian's Report

During the year 1946 periodicals were received:

From Canada and the Empire	46
From the United States of America	65
From other countries	38
Total	149
The number of books loaned from the shelves was	201
Expenditure during the year for binding was	$36.94

New books added to the library. In 1945 *The Story of Science* by David Dietz, 4th edition, 2 copies, were presented by Mr. George T. Dale, for which we express appreciation. By some unaccountable

error which escaped detection the name was printed as Mr. F. Graham in last year's report. Mr. Harold S. Seielstad, a Life Member, in sending notice of change of his address, enclosed $5.00 to be used in sending our publications to needy institutions, for which we express thanks.

During the year we have loaned several sets of lantern slides. A box containing "Dr. Chant's set of 100 slides" has been missing for some time; if anyone knows of the whereabouts of these slides, please send word to the Society office at 3 Willcocks St., Toronto 5.

The necessity of moving was unwelcome but has been survived. We have more room for books, and a comfortable reading room with better facilities for members wishing to make references.

D. W. Best, *Librarian.*

REPORTS OF SECRETARIES OF THE CENTRES

Toronto Centre

The first post-war year was an active one for the Centre with considerably larger attendance at meetings than during the recent war years, and also a notable increase in membership which now stands at 273.

During the year the Centre instituted a campaign to create public interest in the desirability of securing for Toronto a planetarium (of Zeiss or similar type) and it is hoped that funds for this purpose may be made available by some public-spirited citizen or organization. In this connection the Centre had the privilege of welcoming Dr. Roy K. Marshall, director of the Fels Planetarium of the Franklin Institute in Philadelphia, as guest speaker at a largely attended public meeting on April 9 when representatives of civic bodies and business organizations were invited as guests.

The year also saw organization within the Centre of an active amateur telescope makers' group under the leadership of Mr. Raymond Pearce. This A.T.M. group now has about 50 members and several instruments and mirrors are well on their way to completion. The group meets informally to discuss techniques and problems of the preparation of optical parts and the mounting of telescopes.

Meetings: Twelve lecture meetings were held during 1946, and five outdoor summer gatherings with telescopes were planned for the University campus; however, because of bad weather, only three were held.

A return to the pre-war practice of holding the first autumn meeting at the David Dunlap Observatory was much appreciated by more than 150 members and their friends who visited the Observatory on October 8 at the invitation of the director, Dr. Frank S. Hogg. Although clouds prevented telescopic observations, the meeting in the lecture room and the demonstration of the 74-inch telescope and other equipment, was much enjoyed.

The other lecture meetings were held in the McLennan Physics Laboratory of the University of Toronto. Subjects and speakers were as follows:

February 12.—Dr. V. B. Meen: "Stones from Heaven—Meteorites."

February 16.—Flight-Lieut. Rodion Rathbone, B.Sc.: "Radar—What it is and how it works."

A. R. Clute, K.C.: "Theatres of the Stars. Recollections of Visits to the Planetaria in New York and Philadelphia."

March 12.—Dr. J. F. Heard: "How Far's That Star?—How Stellar Distances are Measured." (This meeting commemorated the 100th anniversary of the death of Friedrich W. Bessel.)

March 26.—Dr. H. S. Armstrong: "Dating the Geological Past—The Niagara Escarpment as an Example."

April 9.—Dr. Roy K. Marshall: "The Stars Brought Indoors. The Story of the Planetarium, the Modern Method of Astronomical Education and Entertainment."

April 22.—Dr. Frank S. Hogg: "See for Yourself! Astronomical Observations Which Can be Made with Simple Equipment." (Teachers of science, mathematics and geography attending the annual meeting of the Ontario Education Association were guests of the Centre at this meeting.)

May 23.—Dr. J. A. Pearce: "Recent Investigations of the Pleiades Cluster."

Outdoor meetings with telescopes on the University campus were planned for May 23, June 7, July 5, August 9 and September 6.

October 8.—Open House at the David Dunlap Observatory.

October 22.—Dr. H. R. Kingston: A Demonstration of Celestial Phenomena with Simple Equipment.

November 5.—Messers. Raymond Pearce and Gerald Longworth: "Telescopes and Telescoptics—It's Fun to Make Your Own."

Dr. Ralph E. Williamson: "Sir James Hopwood Jeans, 1877-1946—An Appreciation."

November 19.—John A. Marsh, M.B.E., Ontario Commissioner of the Canadian Red Cross Society: "Exploring Space—An Amateur Looks at the Heavens."

December 3.—Dr. Helen Sawyer Hogg: "The Trials and Triumphs of Tycho Brahe." (Commemorating the 400th anniversary of the birth of Tycho.) The annual business meeting followed.

On Saturday evening, November 9, the members of the Centre were guests of the Royal Canadian Institute when Dr. Helen S. Hogg addressed the Institute on the subject "Along the Milky Way". This meeting was in Convocation Hall of the University of Toronto.

Membership. As of December 31, 1946, there were 273 members on the roll, of whom 11 were life members. There were 51 members elected or added by transfer from other centres during the year, and 25 were removed for various reasons, leaving a net gain of 26.

Mr. Tracy D. Waring, who had been Secretary of the Centre since 1942, tendered his resignation in August, upon moving to East Orange, New Jersey, and President H. W. Barker requested the Recorder to fill both offices until the end of the year.

FREDERIC L. TROYER
Recorder and
Secretary pro tem.

OTTAWA CENTRE

During the year 1946 the following lectures were held:

On February 28, Mrs. Helen Sawyer Hogg, Ph.D., of the David Dunlap Observatory, Richmond Hill, Ontario, spoke on "Beacons of the Milky Way". Mrs. Hogg discussed the extent of the Milky Way system and the distance to its centre. Special mention was made of globular clusters which outline our galaxy. Approximately one hundred people attended.

On March 26, Mr. M. M. Thomson, B.A., of the Dominion Observatory, spoke on "Air Navigation". Mr. Thompson had recently returned from serving as a Flight Lieutenant in the R.C.A.F., where he was a navigational instructor. The lecture was illustrated by slides and a technicolour sound film, "Flying the Weather Map" was shown. There was a large attendance.

On December 5, 1946, Dr. P. M. Millman spoke on "The Stars Fall". The lecture was illustrated with slides and an especially interesting representation of a metor shower was thrown on the screen. The lecturer described the latest advances made in the study of meteors and predicted that we were just on the threshold of a much greater advance. A study of meteors leads to greater knowledge of the upper atmosphere, something that is very much to the fore at the present time. Special mention was made of the October 9th shower.

On April 26, a meeting of the Centre was held at the Dominion Observatory, the Dominion Astronomer, Mr. R. Meldrum Stewart, M.A., and staff holding open house to members and their friends. All the divisions were open to inspection and members of the observatory staff were on hand to explain the work and describe the various instruments. There was a large attendance. As so often is the case, the

night was cloudy and no use of the telescopes could be made. With the serving of refreshments at 10 o'clock a very interesting evening was brought to an end.

Three council meetings were held during the year and other lectures planned, but some of these had to be postponed till early in the new year.

Miss Burland continued to look after the Junior Astronomical Club. Under the care of F. W. Matley and Miss Burland, the sale of Handbooks was very satisfactory. "Sky-Facts" were prepared for the Ottawa Citizen. Members of the Society assisted in observing the meteor shower of October 9.

W. S. McLENAHAN, *Secretary.*

WINNIPEG CENTRE

Seven regular meetings were held in Theatre A of the University of Manitoba. There was a junior and a senior lecture at each meeting except in January when members spoke of their observations of the solar eclipse of 1945. The junior lectures were given chiefly to interest the Boy Scouts and Girl Guides. Two executive meetings were held during the year and two observation nights, one in May and one in September.

In May this Centre held a banquet in honour of Dr. J. A. Pearce, director of the Dominion Astrophysical Observatory, Victoria, B.C., in the Hudson's Bay dining hall. The banquet was followed by a special meeting when Dr. Pearce gave a very interesting lecture.

During the year we suffered the loss of one of our past presidents by the death of Dr. Neil John McLean. Some of our most valued members have moved to other parts of the continent this year. Among these were: Messrs. R. D. Colquette, J. W. Abrams, R. S. Evans and W. R. Junkin.

Over three hundred copies of our 1946 programme were mailed or distributed to High Schools, Boy Scout and Girl Guide groups and to members and interested organizations.

Three new members were voted into the society this year.

C. G. CARD, *Secretary.*

Montreal Centre

During the season 1945-6 the Montreal Centre enjoyed another period of very satisfactory growth and expansion, and we now have 281 members on our roll, as compared with 253 at the same date last year.

A number of distinguished scientists accepted our invitation to speak before the Centre, and in addition a series of lectures entitled "An Introduction to Stellar Astronomy" was given by members of the Montreal Centre. Attendance at lectures was good throughout the year, with 1,121 persons attending the 12 lectures, or an average of 94 per meeting.

Following are the lectures given during the past season:

October 25,—Mr. D. P. Gillmor: "You and the Stars."
November 29,—Dr. W. Bruce Ross: "Tools of the Astronomer."
December 14,—Special meeting to inspect the Planetarium of Montreal High School.
January 10,—S/L P. M. Millman: "R.C.A.F. Operation Eclipse."
January 24,—Mr. F. DeKinder: "The Constellations."
February 14,—Prof. G. H. T. Kimble: "This Weather Business."
February 28,—Mr. Henry F. Hall: "The Stars, Their Nature and Classes."
March 14,—Mr. E. R. Paterson: "The Stars, Their Distances and Motions."
March 28,—Dr. J. D. Cockcroft: "Atomic Energy with relation to the Stars."
April 11,—Dr. Helen S. Hogg: "Beacons of the Milky Way."
April 25,—Mr. J. W. Duffie: "The Stars—Unusual Types."
May 9,—Closing Social
Mr. A. R. McLennan: "The Calendar," Mr. DeLisle Garneau: "Summer Observations;" Dr. D. E. Douglas: "The Solar System."

The observational activities of the Centre also increased, both in variety of observations and in the number of members participating. Well-attended observational meetings were held every Saturday evening throughout the year at the Ville Marie Observatory, the Centre's second annual "Star Night" attracted a large crowd to Westmount Park on June 4, while a similar undertaking, but on a somewhat smaller scale, was held at St. Lambert on October 4, at the invitation of the Lions Club of that City.

At a general meeting held on May 9, 1946, the Montreal Centre unanimously approved a resolution endorsing the World Calendar, and recommending that the General Council of the Society take such action as it might consider appropriate to encourage the adoption of

this calendar. A copy of this resolution was sent to the General Council on May 15, 1946.

The Constitution of the Centre was approved by the General Council of the Society on February 22, 1946, and has therefore been in force since that date.

The weekly column in the Notre Dame des Graces "Monitor" entitled "Observatory Activities" was continued during the past year, and has been of the greatest possible value in keeping the activities of the Centre before the public.

J. W. DUFFIE, *Secretary.*

SUPPLEMENTARY REPORT OF OBSERVATION COMMITTEE

The year 1946 was a record year in nearly all respects for the Montreal Centre. Just as the A.A.V.S.O. reached its millionth mark in observations of variable stars, so did Ville-Marie Observatory its thousandth mark in attendance, the total of 1045 for the year consisting of 889 for R.A.S.C. meetings and 156 for other groups.

One of the highlights of the year was a motor trip on August 3rd to Springfield, Vt., to attend the Amateur Telescope Makers Convention. Twenty-five members and friends participated in this event, a full account of which has appeared in the JOURNAL.

Other highlights were two Star Nights—one on June 4 in Westmount with 17 telescopes, which, in spite of unfavourable weather, attracted about 1500 people; the other, on October 4 in St. Lambert, with 7 telescopes, drew a crowd of about 500.

We have the following observations to report:

The Aurora Group, under the direction of Miss I. Williamson, forwarded a total of 41 monthly and 104 descriptive reports, covering 50 displays, to Dr. Gartlein at Cornell University. Besides these, 57 reports were sent to Dr. Millman during the Musk-Ox Expedition. Seventeen members of the centre were engaged in these observations.

Three occultations were recorded and reported to Dr. Alice Farnsworth of Mount Holyoke College.

Twelve detailed sun-spot reports, the work of three members, were forwarded to the Solar Division of Harvard Observatory.

A total of 171 estimates were made on 153 variable stars for the A.A.V.S.O. by two members of the Centre, with five others assisting.

Ten drawings of Mars were made at the 6-inch refractor from December 11, 1945 to January 13, 1946 and seven drawings of Comet Giacobini-Zinner during the period August 18 to September 15.

The total eclipse of the moon on December 18, 1945 was observed by 22 members of the Centre and a full account submitted to Dr. Chant of the David Dunlap Observatory.

Two meteor showers were observed also, the Perseids and the Giacobinids. Twelve members recorded and plotted 71 Perseids during two and a half hours on the evening of August 11th. Thirty-five members recorded a grand total of 2888 Giacobinids on the evening of October 9th. Good photographs were obtained also. Reports were received from St. Janvier, County of Terrebonne, and from Jonquiere.

The telescope makers were very active too. Miss Williamson and Mr. A. M. Donnelly completed 6-inch reflectors, while Mr. F. W. Henshaw made one 5-inch and Mr. S. Hersvovitch two 5-inch instruments.

A new section was inaugurated by Miss Williamson for younger members and children of members. This was called "The Asteroid Club."

In response to an appeal made by the Department of Ornithology of Harvard College, observations by means of the telescope were carried out on the migration of birds.

Copies of all reports and observations are on file at the Observatory and may be examined by any interested member.

DeLisle Garneau, *Director of Observations.*

Supplementary Report of the Librarian

Interest in and use of the library during the past year has been considerable, the circulation of books being 311 and of periodicals 145.

One of the results of this increase in circulation of almost 100 per cent. is the greater number of books requiring repairs and rebinding, with a consequent reduction in the amount of money available for the purchase of new publications. Fortunately, this has been more than offset by generous donations to the library of books and of money for their purchase. Advantage has been taken of the latter to acquire publications as up-to-date as possible and in keeping with present trends in astronomy and allied sciences.

Six books were purchased with the funds of the Centre, and twenty-four were received as donations, or purchased with money donated for this purpose. Inserted in each of the donated books is a book-plate with the name of the donor inserted thereon—a generous supply of book-plates having been provided by a member of the Centre.

The addition of these volumes brought with it the problem of finding space on our bookshelves. This has been taken care of, for the present at least, by the generous gift of a bookcase for which we are greatly indebted to Miss B. M. Reid.

In order that the Library may be in capable hands in the absence of the Librarian, and to function as such when necessary, a Library Committee has been formed consisting of Mr. A. Scott, Mr. J. Desjardins and Mr. R. Ford. Their assistance at our meetings is very much appreciated.

C. M. Good, *Librarian*

Victoria Centre

Membership. During the year 1946, 29 new members were added to the Centre, whereas 20 were lost to the Centre for the following reasons: deceased, 4; left the city, 2; resigned, 4; dropped for non-payment of fees, 10. The total membership now stands at 119, with a net gain during the year of 9; and includes five life members and two juniors.

Meetings. During 1946, 7 regular meetings and 5 summer course meetings were held. For the programme of "Summer Evenings with the Stars" there was an enrolment of 59 newcomers to the Centre. Of these, 13 have since joined the Centre as regular members.

Joan K. McDonald, *Secretary.*

Supplementary Information from President's Report

The Summer Course was the largest in history—59 members, of whom 13 have joined the Society. Its highlight was the visit to the Observatory, and for this privilege we must again thank our speaker of the evening, Dr. Pearce. We must express our debt to Mr. Brydon for the original suggestion fifteen years ago that such a course would be desirable, and Mr. Shaw for looking after the advertising.

The Observing Section has not been very active during the past few months, since Daylight Saving prevented evening observations in the summer, and somewhat cloudy weather has been our lot for the past few weeks. However an observing course of instruction was carried through in the spring which was well attended.

During the year Miss Langworthy and Mrs. Yarwood drew up the Constitution for the Centre, which has been approved. I feel that they have done an excellent job, and are to be greatly commended.

Here the possibilities of making scientific observations of great value through the Observing Section are almost unlimited and I hope that everyone who has ambitions along that line will let our Director of Telescopes know in order that all may start their observations as soon as possible. For others, who are mechanically minded, I hope that the telescope making section will be able to commence again, under the leadership of Mr. Hobday and Mr. Reid—and that the Moore mounting will be worked on and completed during the coming year.

K. O. Wright, *President.*

London Centre

The London Centre held eight regular monthly meetings during 1946, details of which appear below. All were held in the Hume Cronyn Memorial Observatory, University of Western Ontario. We were very fortunate in having several well qualified and renowned guest speakers, two of whom were Dr. A. E. Johns of Hamilton, Ontario, the President of the Royal Astronomical Society of Canada, and Dr. J. A. Pearce, director of the Dominion Astrophysical Observatory at Victoria B.C.

Meetings were held as follows:

January 11.—Dr. G. R. Magee: "Observer's Handbook Commentary;" Rev. W. G. Colgrove: "Conjunction of Mars and Saturn;" Dr. E. G. Pleva: "Climatology in the Service of Man."
February 8.—Rev. W. G. Colgrove: "Observer's Handbook Commentary;" Mr. Chas. Hanson: "Elementary Astronomical Motions;" Dr. R. H. Cole: "Celestial Mechanics."
March 8.—Dr. H. R. Kingston: "Observer's Handbook Commentary;" Mr. Chas. Hanson: "Celestial Co-ordinates;" Dr. J. K. Watson: "Modern Plastics;" Mr. E. E. O'Connor: "Portable Solar System."
April 12.—Dr. R. C. Dearle: "Problems and Promises from Atomic Energy."
May 17.—Dr. J. A. Pearce: "The Pleiades Cluster."
October 11.—Dr. A. E. Johns: "Atomic Energy."
November 8.—Dr. A. J. Watt: "Canis Major;" Dr. G. R. Magee: "Yardsticks of the Universe."
December 13.—Annual Meeting and Election of Officers. Social evening.

A. Emsley, *Secretary.*

Edmonton Centre

All regular meetings have been held in the Arts Building through the courtesy of the University. The annual meeting took the form of a dinner at the Corona Hotel. The attendance varied from 20 to 43 members and visitors. The Handbook talks were given by Dr. Campbell after the sad passing of the inimitable Mr. Wates.

The main papers were as follows:

December.—Dr. Heber Jamieson: "Astrology and Medicine."
January.—Mr. A. Stockwell: "The Ecliptic and Planetary Motions."
February.—Mr. R. Jacka: "Meteorology and Commercial Flying."
March.—Mr. T. Fostvedt (read by Mr. Keeping): "Calendar Reform."

April,—E. H. Gowan: "Atomic Energy and Stars."
May,—Dr. J. A. Pearce: "Work at Victoria."
October,—A. J. Filmer: "The Aurora."
November,— T. M. Carscadden: "Rockets."

The roll of the Centre now consists of 51 regular members and 3 assoociates.

E. H. Gowan, *Honorary Secretary.*

Centre de Quebec

Notre Centre s'est toujours donné comme objectif immédiat de doter Québec d'un observatoire astronomique. Parmi les divers moyens à sa disposition pour en arriver là, il n'a peut-être pas choisi le moins hasardeux, mais certainement le plus attrayant: réaliser lui-même cette ambition.

Durant l'année qui vient de s'écouler, nous sommes positivement et résolument engagé dans cette voie. Un plan de financement a été étudié et adopté, puis un architecte, ami de notre société, a commencé de travailler sur des esquisses de plans. Comme hommage au grand public, qui a si bien secondé notre jeune société dans ses efforts, il a été décidé réserver les souscriptions populaires à l'achat du principal télescope du futur observatoire. Un comité spécial a donc été formé, dont le travail consistera à organiser une campagne de souscription dans le public. Le Comité du Télescope, comme on l'appelle, entend opérer un minimum de trois années.

Le Centre de Québec a tenu assez régulièrement ses réunions mensuelles. Le 23 février, M. Roland Bernier, nous a parlé de "Notre Satellite, la Lune." Le 13 avril, M. Georges-E. Gagné a expliqué la réforme du calendrier, telle que proposée par la World Calendar Association, et a donné son opinion personnelle. A la même séance, M. Edgar Latulippe a lu un travail intitulé: "Résumé de l'histoire de l'astronomie." Le 18 mai, M. Oscar Villeneuve, Directeur du Bureau de Météorologie, a parlé des "Bases scientifiques de la météorologie moderne." A chacune de ces séances, M. Charles-A. Giroux a présenté comme d'habitude ses intéressantes descriptions du ciel du mois.

A l'automne, deux réunions seulement ont eu lieu. Le 28 septembre, pour commémorer le centenaire de la découverte de Neptune, M. Roland Bernier a lu un travail sur Le Verrier. Enfin, le 18

décembre, une réunion spéciale a été organisée, à laquelle le grand public fut invité. Le conférencier était le Révérend Frère Robert, qui avait choisi le sujet suivant: "L'astronomie à l'école des grands littérateurs."

L'effectif de nos membres a été porté à 88 au cours de l'année, soit un peu plus de la moyenne des trois dernières années, qui s'établit à 80.5. Les visites populaires à l'Observatoire provisoire de la Société, ont accusé une très forte augmentation: de 1829 qu'elles étaient en 1945, elles sont passé à 2739, et ce chiffre ne comprend que les visiteurs qui ont signé le registre. Le Graphique du Ciel, édité pour nous à titre gracieux par l'Académie des Sciences du Maryland, à Baltimore, est toujours excessivement populaire et notre liste de distribution double chaque année.

La Fête du Soleil a été célébrée le dimanche 23 juin. A cette occasion, l'observatoire a été ouvert au public durant l'après-midi, et une moyenne de cent personnes à l'heure ont pu observer les taches du Soleil. Les visiteurs ont aussi été admis à l'observatoire toute la nuit, qui ne dure que deux heures et demie, à cette date. Le 5 août, nous avons organisé une autre soirée populaire en plein air, cette fois à Saint-Valier. Le programme était le même que d'habitude: films astronomiques et séance d'observation avec instruments portatifs.

Un ciel s'éclaicissant vers les 9 heures, dans la nuit du 9 au 10 octobre, nous a permis d'observer les Giacobinides dans toute la splendeur du possible. Le maximum s'est produit entre 10 h. 55 et 11 h. 00, alors que nous avons observé 152 météores par minute. Le total des météores enregistrés a été de près de 8000 entre 9 h. et 11 h. 30.

A l'occasion de l'éclipse de Soleil du 23 novembre, M. Giroux et ses compagnons avaient une installation très élaborée à l'Observatoire pour filmer les contacts, mais le ciel est resté à peu près complètement nuageux toute la durée de l'éclipse.

Un total de 970 mesures d'étoiles variables ont été effectuées à l'observatoire de décembre 1945 à octobre 1946, contre 928, de décembre 1944 à novembre 194. La marque de 5000 étoiles, mesurées à l'observatoire provisoire de la Tour Martello, a été atteinte le 27 juillet de cette année. Un membre de notre Centre, M. Gérard Lafontaine, qui s'est construit un observatoire à Saint-Gervais (Belle-

chasse), a aussi abordé les mesures d'étoiles variables. De janvier à septembre, il a effectué 88 mesures sur 40 variables différentes, qui s'accordent parfaitement avec les nôtres effectuées à Québec. M. Lafontaine mesure avec un télescope de 8 pouces qu'il s'est entièrement construit lui-même. Ses travaux lui ont mérité le Prix des Fondateurs, qui lui été décerné à la séance du 23 février.

PAUL-H. NADEAU, *Le secrétaire.*

WINDSOR CENTRE

As we complete our second year of activity as a centre of the Royal Astronomical Society of Canada, we view with satisfaction the increased interest in Windsor in astronomy, as evidenced by the larger attendances at all our meetings, and by the many new members. During 1946 ten public meetings and two council meetings were held. With two exceptions the public meetings were held in the lovely Art Gallery room of Willistead Library through the kindness of the Chief Librarian, Miss Anne Hume, and the Windsor Public Library Board.

Our June meeting was at the summer home of the Vice-President, D.C. Bawtenheimer. On May 31st we joined with the Engineering Institute of Canada, Border Cities Branch, in a joint meeting at the Prince Edward Hotel. At each meeting a member has outlined the astronomical events of the following month. Weather permitting, observations with the four-inch refracting telescopes followed the meetings. Our membership has increased during the year from 45 to 59, and the average attendance has been 60 members and visitors.

The Windsor Centre enjoys the co-operation of the Detroit Astronomical Society. Members of each Society are frequent visitors at the other's meetings. Two Detroit members are on the Windsor Council and are of invaluable assistance in arranging for guest speakers from Michigan to address our Centre. Mrs. Margaret Back, secretary of the Detroit Society, has been especially kind and helpful. Several members availed themselves of the opportunity to visit the beautiful Cranbrook School, Bloomfield Hills, Michigan, on Sunday, June 9. The President of the Detroit Society, Wm. Schultz, Jr., was instrumental in arranging this delightful gathering. Mr.

Schultz who is head of the science department at the Cranbrook School also helped arrange the National Convention of the Amateur Astronomers of America on July 5-7. Our official delegate, Mr. Charles A. Bell, reported at our November meeting that the convention was an outstanding success and an enjoyable experience. Among other members from Windsor we note Mr. Gerald S. Spracklin who was awarded First Prize in the Exhibits of Telescope Accessories for his ingeniously-constructed phonograph motor drive geared to keep his telescope directed at its astronomical object.

The speakers and subjects of the addresses at the meetings were:

January 8.—Lee F. McGee, B.A.: "Atomic Energy."

February 12.—Cameron H. Montrose, B.Sc.: "Glaciation and the Ontario Landscape."

March 12.—Prof. Orren C. Mohler, Ph.D., University of Michigan: "Some Problems of Solar Research."

April 9.—Wm. Schultz, Jr., B.S.E., M.S.Ed.: "Electronics, a Rapidly Expanding Science."

May 7.—Frederick W. C. Jones, B.S.: "Eclipse Instruments, their Design and Operation."

May 31.—W. Almon Hare, B.A.Sc.: "Glories of the Heavens"; Joint Meeting with Border Cities Branch, E.I.C.

June 12.—Outdoor meeting at Poplar Lodge—intended astronomical observations became meteorological—a fine display of "Summer lightning," and aurorae. Cyril Hallam, B.A.: "Meteor Craters and other Phenomena;" Gregory Rawlings, B.A.: "Telling Time by the Stars."

The members were entertained and refreshed by Mr. and Mrs. Bawtenheimer.

October 8.—Prof. H. R. Kingston, Ph.D.: "Demonstration of Celestial Phenomena with Instruments and Models."

November 12.—Claude B. Carpenter, A.A.V.S.O., Wayne, Mich.: "Telescopes, Observing Conditions, Observatories and Celestial Photography."

December 10.—Hugh S. Cunningham, B.A.: "The Christmas Star." Annual Meeting followed by social hour and refreshments.

A new feature of our meetings is the Library Service. Through the co-operation of the Windsor Public Libraries books on astronomy and cognate subjects are on display at each meeting. Councillor E. J. Edwards is Librarian and members and visitors may borrow the books for a period of one month.

Our meetings are publicized throughout the secondary schools of Windsor and many students attend. "The Windsor Daily Star" carries an announcement on the Saturday preceding each meeting. As a result of the growing interest in astronomy in Windsor, members have presented addresses to various groups in the city.

RUSSELL G. WARWICK, *Secretary.*

FINANCIAL STATEMENTS, 1946

I. GENERAL TREASURER

General Account

Bank balance December 31, 1945		$1,033.55
Receipts		
Grants Received—Ontario	$ 500.00	
Canada	1,620.00	
Donation—Toronto centre	100.00	
Fees	3,280.87	
Subscriptions	445.87	
Publications	883.11	
U.S.A. Exchange	58.29	
Canada Permanent Debenture	500.00	
Bond Interest	94.38	
Bank Interest	.47	7,482.99
		8,516.54
Disbursements		
Publications	3,523.47	
Grants to Centres	1,082.91	
Stamps and Stationery	147.20	
Salary	913.00	
Rent	390.00	
Janitor Service	4.50	
General Expense	126.21	
Audit	40.00	
Moving Expense	103.66	
Chant Medal	6.75	
Exchange	43.15	6,380.85
Balance in bank December 31, 1946		$2,135.69

BUILDING ACCOUNT

Bank balance December 31, 1945		202.50
Bank Interest	.31	
Bond Interest	216.36	216.67
Balance in bank December 31, 1946		$419.17

LIFE MEMBERSHIP

Receipts		Disbursements	
Bank balance Dec., 31, 1945	$119.48	Safe Keeping of Bonds	4.00
Life Membership	250.00	Bank balance Dec. 31, 1946	365.48
	$369.48		$369.48

SOUTHAM PRESS FUND

(Cash balance deposited in General Account)

	Dr.		Cr.
Bank balance Dec., 31, 1945	$103.14	Chant medal	$ 6.75
Bank interest	1.05	Balance	162.94
Bond interest	65.50		
	$169.69		$169.69

SUMMARY: BONDS AND DEBENTURES HELD FOR R.A.S.C. BY IMPERIAL BANK

Account	Dec. 31, '45	Purchased 1946	Sold 1946	On hand Dec. 31 1946	Yearly interest
Life members	$ 900.00		$	$ 900.00	$28.88
Building fund	6,700.00		500.00	6,200.00	216.36
Southam Press	2,050.00			2,050.00	65.50
	$9,650.00		$500.00	$9,150.00	$310.74

Note: The bond sold during the year was credited to General Account.
Toronto: January 4, 1947.

Audited and certified correct:

H. M. Moncrief, *Certified Accountant.*

J. H. Horning, *General Treasurer.*

BALANCE SHEET DECEMBER 31ST, 1946

Assets

Cash on hand in bank		
Imperial Bank of Canada		$2,795.34
Invested in bonds		
Life members	$ 900.00	
Building fund	6,200.00	
Southam Press	2,050.00	9,150.00
Accounts receivable		259.85
Inventory of Publications		751.00
Prepaid insurance		17.00
Furniture and fixtures		
Estimated value December 31, 1944	4,684.00	17,657.19

LIABILITIES

Accounts Payable		1,679.31	
Surplus December 31, 1945	$14,874.62		
Revenue in excess of expenses	1,103.26	15,977.88	$17,657.19

Audited and certified correct:

H. M. MONCRIEF, *Certified Accountant.*

J. H. HORNING, *General Secretary.*

EXPLANATORY NOTES

The audited financial statement, although correct, does not truly show the financial situation connected with operations during 1946. That it presents too favourable a picture will be realized from the following considerations.

Receipts not received from normal operations for 1946:

(1) (*a*) Fees past due, (*b*) prepaid, (*c*) new life members	$457.00
(2) Loan from Building Fund—to be repaid—debenture	500.00
(3) Donation from Toronto Centre, not a normal receipt	100.00
(4) Bond Interest—belongs to special Southam Press Fund and is not to be expended for general operations	65.50
Total recipt not received from normal 1946 operations	1,122.50

Expenditures not paid but owing on account of 1946:

Accounts payable increase on Dec. 31 over Jan. 1, 1946	434.00

RECAPITULATION OF FINANCIAL OPERATIONS FOR 1946 ONLY

Receipts as per audited statement	7,482.99
Deduct receipts not received from normal 1946 Operations	1,122.50
Net normal receipts	6,360.49
Expenditures as per audited statement	6,380.85
Add increase in unpaid accounts due to 1946 operations	434.00
Net normal expenditure	6,814.85
Net deficit due to normal 1946 operations	454.36

The fact that the deficit is below the $800.00 predicted in November was achieved by the following actions:

(1) Cancellation of the issue of the JOURNAL for one month.

(2) Very favourable collections of fees by the 11 centres.

(3) Penurious economy of the Headquarters of the Society with the resultant loss of ability to keep all work completed up to date.

II. REPORTS OF TREASURERS OF CENTRES

TORONTO CENTRE

Receipts		Disbursements	
Balance from previous year	$401.14	Rentals	$ 51.00
Grant from General Council	225.00	Printing & Stationery	26.87
Cash Received re Jewell Printing a/c for General Society	.75	Expenses re Speakers	121.52
		Postage & Telegram (Toronto Centre)	6.07
		Postage per General Treasurer.	14.15
		Grant to General Society for Office Expenses	100.00
		Balance carried forward	307.28
Totals	$626.89		$626.89

T. H. Mason, *Treasurer.*

HAMILTON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 29.63	Rentals	$ 22.00
Members' Fees	106.00	Fees to General Treasurer	100.00
Grant from General Council	42.00	Postage and Stationery	17.92
Bank interest	.86	Expenses re meeting	4.00
Donation	2.00	Printing	16.68
		Balance carried forward	19.89
Totals	180.49		180.49

George Murchie, *Secretary-Treasurer.*

WINNIPEG CENTRE

Receipts		Disbursements	
Balance from previous year	$ 55.95	Rentals	$ 10.00
(27) Members' Fees	54.00	Fees to General Treasurer	54.00
Grant from General Council	37.00	Postage and Stationery	17.78
Bank interest	1.26	Expenses re meeting	13.40
Junior Membership Fees	1.50	Exchange	.15
		Balance carried forward	54.38
Totals	$149.71		$149.71

C. D. Dorsett, *Treasurer.*

OTTAWA CENTRE

Receipts		Disbursements	
Balance from previous year	$290.65	Fees to General Treasurer	$235.33
(52) Members' Fees	142.85	Printing and Stationery	10.06
Grant from General Council	52.00	Postage	5.55
Sales of Observer's Handbooks.	31.40	Expenses of public meetings	104.78
Bank interest	1.14	Cost of Observer's Handbooks.	45.25
		Miscellaneous	2.00
		Balance carried forward	115.07
Totals	$518.04		$518.04

F. W. Matley, *Treasurer.*

MONTREAL CENTRE

Receipts		Disbursements	
Balance October 16, 1945	$ 65.59	Postage	$ 62.93
Membership Fees 7 Life, 261 Annual	697.00	Stationery	18.90
Bank Interest	5.02	Expenses re Meeting	98.57
Miscellaneous	24.50	Library	24.05
Grant from General Treasurer.	283.50	Advertising	31.95
		Equipment	11.24
		Miscellaneous	9.25
		Fees to General Treasurer	697.00
		Balance in Bank October 15, 1946	121.72
Totals	$1,075.61		$1,075.61

A. R. MacLennan, *Treasurer.*

VICTORIA CENTRE

Receipts		Disbursements	
Balance from previous year	$ 80.60	Rental	$ 3.50
Members' Fees	218.00	Fees forwarded to General Tr. (1945-$116.25; 1946-$218.00)	334.25
Grant from General Council	125.25	Postage Stationery	28.83
Bank interest	1.15	Expenses re Meetings	26.21
Interest on bond	6.75	Printing	8.00
		Exchange on Cheques	.78
		Library of Centre	13.42
		Equipment for Observatory	10.00
		Balance carried forward	6.76
Totals	$431.75		$431.75

Jean K. McDonald, *Treasurer.*

LONDON CENTRE

Receipts		Disbursements	
Balance from previous year	$ 87.33	Fees forwarded to General Tr.	$ 84.00
Members' Fees	78.00	Postage Stationery	6.19
Grant from General Council	43.00	Expenses re Meetings	20.00
Bank interest	.13	Miscellaneous	5.70
		Balance carried forward	92.57
Totals	$208.46		$208.46

VANCOUVER CENTRE

Receipts		Disbursements	
Balance from previous year	$ 2.22	Fees forwarded to General Tr.	$ 90.00
Members Fees (1946)	88.00	Postage Stationery	10.00
Members' Fee (1945)	2.00	Expenses re Meetings	50.30
Grant from General Council	46.00	Printing	20.73
Bank interest	.20	Deficit carried forward	32.36
1 Manual	.25		
Totals	$138.67		$138.67

G. W. Owen, *Treasurer.*

EDMONTON CENTRE

Receipts		Disbursements	
Balance from previous year	$139.46	Rental	$ 12.03
Members' Fees	95.00	Fees to General Treasurer	198.09
Grant from General Council	51.35	Postage Stationery	3.45
Bank interest	1.82	Expenses re Meetings	4.15
		Miscellaneous	40.46
		Balance carried forward	29.45
Totals	$287.63		$287.63

A. M. P. Smith, *Treasurer.*

WINDSOR CENTRE

Receipts		Disbursements	
Balance from previous year	$ 11.63	Postage and Stationery	$ 7.84
Members' Fees (50 adult, 10 jun.)	110.00	Sky and Telescope etc.	8.00
Grant from General Council	34.00	Fees to General Treasurer	110.00
Miscellaneous	.43	Expenses re Meetings	24.45
		Balance carried forward	5.77
Totals	$156.06		$156.06

CENTRE DE QUÉBEC

Recettes		Déboursés	
Solde au 15 décembre 1945	$ 7.15	Cotisation au Trésorier gén.	$172.00
Octroi du Secrét prov. 1944-5.	300.00	Remboursement emprunt 1945	100.00
Octroi du Secrét. prov. 1945-6.	300.00	Electricité	50.70
Octroi du Trésorier général	143.50	Téléphone	60.39
Cotisations 1943-1945	18.00	Timbres-poste	34.60
Cotisation 1946	109.00	Administration	140.40
Cotisations 1947	36.00	Propagande	66.00
Dons	114.19	Frais de transport	24.25
Cercle Léon Foucault	64.25	Entretien	51.24
Intérêt de banque	.70	Cercle Léon Foucault	59.67
		Solde en banque	333.54
Totals	$1,092.79		$1,092.79

Lionel Gallichan, *Le Trésorier.*

OFFICERS FOR 1947

Honorary President—The Honourable George A. Drew, Prime Minister and Minister of Education for the Province of Ontario.
President—J. W. Campbell, Ph.D., Edmonton, Alta.
First Vice-President—Andrew Thomson, M. A., Toronto.
Second Vice-President—C. S. Beals, Ph.D., Ottawa, Ont.
General Secretary—E. J. A. Kennedy, 3 Willcocks St., Toronto.
General Treasurer—J. H. Horning, M.A., Toronto.
Recorder—H. W. Barker, Toronto.
Librarian—D. W. Best, D.D., Toronto.
General Council—Albert Bouvin, B.Sc., Quebec, P.Q.; S. C. Brown, Toronto; A. J. Crook, Edmonton, Alta.; G. Harper Hall, Montreal, P. Q.; Helen S. Hogg, Ph.D., Toronto; H. R. Kingston, Ph.D., London, Ont.; L. T. S. Norris-Elye, Winnipeg, Man.; Robert Peters, Victoria, B.C.; Lorne R. Rogers, B.A., Windsor, Ont.; H. D. Smith, Ph.D., Vancouver, B.C.; W. D. Stewart, B.A., Hamilton, Ont.; M. M. Thomson, B.A., Ottawa, Ont.; and past presidents A. Vibert Douglas, M.B.E., Ph.D., and A. E. Johns, Ph.D.; also the presiding officer of each centre.

TORONTO CENTRE

Honorary President—C. A. Chant, Ph.D.
President—J. F. Heard, Ph.D.
First Vice-President—A. R. Clute, K.C.
Second Vice-President—Frank S. Hogg, Ph.D.
Secretary—Frederic L. Troyer
Treasurer—T. H. Mason
Recorder—J. R. Tuck, D. Educ.
Council—H. G. Duncalfe, J. H. Horning, Miss Eva Smith, C. A. Crook, Helen S. Hogg, Ph.D., W. R. Sherrick, F. K. Dalton, B.A.Sc., E. E. Raymond Pearce, R. E. Williamson, Ph.D.; and past presidents E. J. A. Kennedy, J. R. Collins, S.C. Brown, D. W. Best, D.D.; Miss R. J. Northcott, M.A.; and H. W. Barker.

OTTAWA CENTRE

Honorary President—Hoyes Lloyd, M.A.
President—M. M. Thomson, B.A.
First Vice-President—P. M. Millman, Ph.D.
Second Vice-President—M. J. S. Innes, M.A.
Secretary—Miss C. B. Hicks, B.A.
Treasurer—Stanley Mott
Council—W. S. McClenahan, B.A., R. J. McDairmid, Ph.D., R. G. Madill, B.A., R. M. Stewart, M.A., A. H. Miller, M.A.; and past presidents Miss M. S. Burland, B.A., L. T. Tanton, Ph.D., and F. W. Matley.

HAMILTON CENTRE

Honorary President—W. T. Goddard
President—Rev. E. F. Maunsell, M.A.
Vice-President—T. M. Norton
Secretary-Treasurer—G. Murchie
Curator—G. E. Campbell
Council—W. Findlay, Ph.D., A. E. Johns, Ph.D., J. R. Graham, F. Schneider, W. S. Mallory, M.A., S. Sisman, W. D. Stewart, B.A., H. B. Fox, D. G. Burns, W. J. McCallion, L. O. Jones, O. Paton.

WINNIPEG CENTRE

Honorary President—Dr. L. A. H. Warren
President—D. R. P. Coats
Vice-President—R. A. Storch
Secretary—Miss Beverley Sharman
Treasurer—Miss Margaret E. Watterson
Press Secretary—C. G. Card
Council—Miss Olive Armstrong, Mrs. J. Norris, L. T. S. Norris-Elye, V. C. Jones, L. W. Koser and H. E. Riter.

MONTREAL CENTRE

Honorary President—Mgr. C. P. Choquette
President—Henry F. Hall
First Vice-President—F. De Kinder
Second Vice-President—Dr. W. Bruce Ross
Secretary— J. W. Duffie
Treasurer—A. R. MacLennan
Recording Secretary—Miss I. K. Williamson
Director of Observations—DeLisle Garneau
Librarian—C. M. Good
Council—A. M. Donnelly, Dr. D. E. Douglas, Ross Ford, G. Harper Hall, F. W. Henshaw, Arthur Kneeland, F. P. Morgan, W. H. C. Morton, E. Russell Paterson, Dr. A. Norman Shaw and past president D. P. Gillmor, K.C.

VICTORIA CENTRE

Honorary President—R. M. Petrie, Ph.D.
President—Andrew McKellar, Ph.D.
First Vice-President—W. R. Hobday
Second Vice-President—J. S. Stevenson, Ph.D.
Secretary-Treasurer—Miss J. K. McDonald
Recorder—G. L. Darimont
Director of Telescopes— R. Peters
Librarian—Miss Y. Langworthy
Council— Robt. S. Evans, Mrs. J. R. Noble, E. H. Pope, H. A. Reid, M. Trueman, Mrs. C. S. Yarwood.

LONDON CENTRE

Honorary President—H. R. Kingston, Ph.D.
President—Dr. A. J. Watt
Vice-President—O. Kilburn
Secretary-Treasurer—Albert Emsley
Council—Dr. G. Calder, Mrs. D. M. Hennigar, J. C. Higgins, Mrs. G. Wood.

EDMONTON CENTRE

Honorary President—J. W. Campbell
President—F. C. Blower
Vice-President—D. B. Scott
Secretary—E. H. Gowan
Treasurer— Miss A. M. P. Smith
Librarian—E. S. Keeping
Council—W. Wyman, A. J. Filmer, S. G. Deane, H. A. McGregor, W. E. Mjolsness.

QUEBEC CENTRE

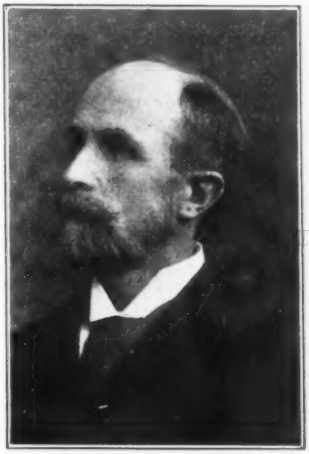
Patron—Mgr. Ferdinand Vandry
Honorary President—Arthur Amos, I.C.
President—J.-Lucien Pouliot, C.G.A.
First Vice-President—Lionel Lemieux, B.A., Ll.L.
Second Vice-President—Geo.-Etienne Gagné
Secretary-Treasurer—Paul-H. Nadeau
Council—Jean-Chs. Magnan, B.A., B.Sc.Ag., l'abbé Rosario Benoît, l'abbé Emilien Gauthier, Albéric Boivin, B.Sc.Ap., M-Louis Carrier, I.C., Charles-A. Giroux, Lloyd McWilliams, El. E., Oscar Villeneuve, I. F., Ph.D., Claude Frémont.

WINDSOR CENTRE

Honorary President—E. R. Phelps, Ph.D.
President—Cyril B. Hallam, B.A.
Vice-President—Daniel C. Bautenheimer
Treasurer—Charles A. Bell, B.A.
Secretary—Russell G. Warwick, B.A.
Librarian—E. J. Edwards
Council—Mrs. Margaret Back, Hugh S. Cunningham, B.A., Robert T. Graham, B.T.C., W. Almon Hare, B.A.Sc., Frederick W. C. Jones, B.S., E. M. Krebser, B.A.Sc., Hugh Murray, B.A., William J. Person, Gregory Rawlings, B.A., Lorne R. Rogers, B.A., W. A. Roberson, Gerald S. Spracklin, Gordon E. Turner and past president Cameron H. Montrose, B.Sc.

ALLAN FREDERICK MILLER, 1851-1947

By J. R. Collins



Allan Frederick Miller

Allan Frederick Miller was born in Dublin, Ireland, in 1851, and died at his home in Toronto on February 2, 1947. Son of Captain John Miller, Master of an English vessel doing duty between the British Isles, Bermuda and South America, Allan while a small boy accompanied his father a few times and had the pleasure of viewing the brilliant stars of the Southern Cross from the vessel's deck. Retiring from the sea, Captain Miller with his family came to Canada and settled at Newtonbrook, then a suburb of Toronto, where Allan attended Willowdale School and first became interested in astronomy by an extension class formed there by the teacher.

After the death of Captain Miller the family moved to Toronto and Allan became a pupil at the Model School where he attained to the highest Form. From there he entered the business world where his recognized integrity, remarkable memory and high attainments enabled him to eventually become Secretary-Treasurer of the Toronto General Hospital, which position he retained for 43 years, retiring in 1918. He helped to build up that great institution and the various properties belonging to it. Still maintaining his interest in astronomy he became one of the founders of the Royal Astronomical Society of Canada and its President in 1918. Mr. Miller became something of an authority in spectroscopy extending his field beyond strictly astronomical matters; he was credited with being the first to secure a definite spectrum of the light of the fire-fly. In later years he became totally blind.

Whatever Mr. Miller undertook to do he did well. He had an observatory built at his home. He purchased a clock-controlled tele-

scope with spectroscopic attachments and accessories,* with which creditable work was done, reports being made from time to time to the Society's meetings. On a number of occasions the members were entertained in the observatory. Mr. Miller's intellectual faculties were retained to the last to a remarkable degree, discussing recent advances in astronomy and physics with his daughter and the astronomical friends who frequently visited him. Surviving are his daughter, Miss Gabrielle Miller of Toronto, and his son Professor F. R. Miller, M.D., F.R.S., of Western University, London, Ontario.

> All noble spirits live again in hearts that love the truth,
> 'Tis this that makes sublime the lowliest, and nerves the timid soul
> To climb life's rugged path, and soothes the wound that smarts;
> And the Eternal God of justice judges not poor human nature
> By its hapless lot but by its loyalty to inward light.

*This telescope was purchased by H. Boyd Brydon, Victoria, B.C., and later by the Victoria Centre of this Society.

The Royal Astronomical Society of Canada

OFFICERS FOR 1946

Honorary President—THE HONOURABLE GEORGE A. DREW, Prime Minister and Minister of Education for the Province of Ontario.
President—A. E. JOHNS, PH.D., Hamilton, Ont.
First Vice-President—H. BOYD BRYDON, Victoria, B.C.
Second Vice-President—J. W. CAMPBELL, PH.D., Edmonton, Alta.
General Secretary—E. J. A. KENNEDY, 3 Willcocks St., Toronto 5
General Treasurer—J. H. HORNING, M.A., Toronto
Recorder—H. W. BARKER, Toronto
Librarian—D. W. BEST, D.D., Toronto
General Council—S. C. BROWN, Toronto; G. E. CAMPBELL, M.A., Hamilton, Ont.; W. G. COLGROVE, M.A., B.D., London, Ont.; G. HARPER HALL, Montreal, P.Q.; CYRIL B. HALLAM, B.A., Windsor, Ont.; HELEN S. HOGG, PH.D., Toronto; P. H. NADEAU, M.Sc., Quebec; ROBERT PETERS, Victoria, B.C.; ANDREW THOMSON, M.A., Toronto; M. M. THOMSON, B.A., Ottawa; H. D. SMITH, PH.D., Vancouver, B.C.; ———— Edmonton, Alta., and Past Presidents—F. S. HOGG, PH.D., and A. VIBERT DOUGLAS, M.B.E., PH.D.; also the presiding officer of each centre.

TORONTO CENTRE

Honorary President—C. A. CHANT, PH.D. *President*—H. W. BARKER
First Vice-President—A. R. CLUTE, K.C. *Second Vice-President*—FRANK S. HOGG, PH.D.
Secretary—TRACY D. WARING, 44 Rose Park Drive, Toronto 12
Treasurer—T. H. MASON *Recorder*—FREDERIC L. TROYER
Council—J. F. HEARD, PH.D.; GEORGE T. DALE; R. S. DUNCAN; S/L P. M. MILLMAN; J. H. HORNING, M.A.; H. G. DUNCALFE; HELEN S. HOGG, PH.D.; C. A. CROOK; W. R. SHERRICK; and Past Presidents—J. R. COLLINS; E. J. A. KENNEDY; S. C. BROWN; REV. D. W. BEST; MISS R. J. NORTHCOTT, M.A.

OTTAWA CENTRE

Honorary President—T. L. TANTON, PH.D. *President*—HOYES LLOYD, M.A.
First Vice-President—F/L M. M. THOMSON, B.A.
Second Vice-President—R. J. MCDIARMID, PH.D.
Secretary—W. S. MCCLENAHAN, B.A., Dominion Observatory, Ottawa
Treasurer—F. W. MATLEY, ESQ.
Council—MISS C. B. HICKS, B.A.; R. G. MADILL, B.A.; A. H. MILLER, M. A.; VALMER A. NIXON; C. B. REILLY, K.C.

HAMILTON CENTRE

Honorary President—W. T. GODDARD *President*—REV. E. F. MAUNSELL
Vice-President—T. M. NORTON,
Secretary-Treasurer—G. MURCHIE; 77 Fennell Ave. W. *Curator*—MR. G. E. CAMPBELL, M.A.
Council—DR. W. FINDLEY; DR. A. E. JOHNS; W. D. STEWART, B.A.; D. G. BURNS; F. S. SISMAN; W. S. MALLORY, M.A.; H. B. FOX; J. W. MCCALLION, B.A.; F. H. BUTCHER, B.A.; J. R. GRAHAM; F. SCHNEIDER; V. TAYLOR.

WINNIPEG CENTRE

Honorary President—PROF. L. A. H. WARREN *President*—MISS O. A. ARMSTRONG
First Vice-President—A. P. MORSE *Secretary*—C. G. CARD, 1197 Dominion St.
Treasurer—C. D. DORSETT *Press Secretary*—L. W. KOSER
Council—L. J. CROCKER; MRS. J. NORRIS; R. A. STORCH; D. R. P. COATS; L. T. S. NORRIS-ELYE; V. C. JONES.

MONTREAL CENTRE

Honorary President—MGR. C. P. CHOQUETTE *President*—HENRY F. HALL
Vice-President—F. J. DEKINDER
Secretary—J. W. DUFFIE, 582 Mercille Ave. St. Lambert, Mtl. 23
Treasurer—A. R. MACLENNAN *Recording Secretary*—MISS I. K. WILLIAMSON
Director of Observations—DELISLE GARNEAU *Librarian*—C. M. GOOD
Council—DR. D. E. DOUGLAS; G. HARPER HALL; F. W. HENSHAW; PROF. A. H. S. GILLSON; F. T. MATTHEWS; F. P. MORGAN; R. RUSSELL PATERSON; DR. W. BRUCE ROSS; DR. A. NORMAN SHAW; and Past President—DAN. P. GILLMOR, K.C.

VICTORIA CENTRE

Honorary President—R. M. PETRIE, PH.D. *President*—K. O. WRIGHT, PH.D.
First Vice-President—A. MCKELLAR, PH.D. *Second Vice-President*—W. R. HOBDAY
Secretary-Treasurer—MISS J. K. MCDONALD, B.Sc., Dom. Astrophysical Observatory
Recorder—LT.-CMDR. A. M. P. SCAIFE *Librarian*—MISS Y. LANGWORTHY
Council—H. J. CHALK; MRS. J. R. NOBLE; H. A. REID; DR. J. S. STEVENSON; M. TRUEMAN; MRS. C. S. YARWOOD

LONDON CENTRE

Honorary President—DR. H. R. KINGSTON *President*—DR. R. H. COLE
Vice-President—DR. A. J. WATT *Secretary-Treasurer*—A. EMSLEY, 831 Richmond Street
Council—W. E. SHALES; DR. L. M. SPRATT; DR. G. CALDER; CHAS. HANSON; MRS. D. M. HENNIGAR

VANCOUVER CENTRE

Honorary President—DR. G. M. SHRUM *President*—DR. H. D. SMITH
Vice-President—N. BARTON *Recording Secretary*—C. D. MAUNSELL
Secretary—MARGARET S. GEORGE, 4497 West 13a Ave. *Treasurer*—MISS G. W. OWEN
Council—E. M. PRICE; MRS. C. A. ROGERS; MR. N. D. B. PHILLIPS; MRS. G. T. GILPEN; A. OUTRAM; B. CATTERALL; MRS. ANDERSON.

(Continued at bottom of next page)

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
1890-1946

The Society was incorporated in 1890 under the name of The Astronomical and Physical Society of Toronto, and assumed its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London and Windsor, Ontario; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as over 1,000 members of these Canadian Centres, there are over 400 members not attached to any Centre, mostly resident in other nations, while some 50 additional institutions or persons subscribe to our publications.

The Society publishes a monthly "Journal" containing about 500 pages and a yearly "Observer's Handbook" of 80 pages. Single copies of the "Journal" or "Handbook" are 25 cents, postpaid. In quantities of 10 or more copies, the price is 20 cents a copy.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 3 Willcocks St., Toronto.

The Society has for Sale:

Reprinted from the "Journal" of the Royal Astronomical Society, 1936-1944.

The Physical State of the Upper Atmosphere, (revised 1941) by B. Haurwitz, 96 pages; Price 75 cents postpaid.

General Instruction for Meteor Observing, (revised 1940) by Peter M. Millman, 24 pages; Price 15 cents postpaid.

A Yoke Mounting for the Six-inch Telescope, by H. Boyd Brydon, 8 pages; Price 10 cents postpaid.

Setting Up and Adjusting the Equatorial Reflecting Telescope, by H. Boyd Brydon, 25 pages; Price 25 cents postpaid.

Occultations: their Prediction, Observation and Reduction, by H. Boyd Brydon, 76 pages, 1944; Price 60 cents.

In quantities of ten or more copies, a discount of 20 per cent will be allowed. Send Money Order to 3 Willcocks St., Toronto.

(Continued from previous page)

EDMONTON CENTRE

Honorary President—J. W. CAMPBELL
President—M. WYMAN
Vice-President—F. C. BLOWER
Secretary—F. H. GOWAN, University of Alberta
Treasurer—MISS A. M. P. SMITH
Librarian—E. S. KEEPING
Social Hostess—MISS M. BOWMAN
Council—A. J. COOK; D. B. SCOTT; H. J. MONTGOMERY; T. M. CARSCADDEN.

CENTRE DE QUEBEC

Patron—MGR. FERDINAND VANDRY, P.A., V.G., Recteur de l'Université Laval
Président Honoraire—ARTHUR AMOS, I.C.
Président—JEAN-CHS. MAGNAN, B.A., B.S.A.
1er Vice-Président—LUCIEN POULIOT, C.G.A.
2ème Vice-Président—LIONEL LEMIEUX, B.A., LL.L.
Secrétaire—PAUL-H. NADEAU, M.Sc., 275 rue St. Cyrille
Trésorier—LIONEL GALLICHAN
Membres du Conseil—M.M. L'ABBÉ ROSARIO BENOIT; L'ABBÉ EMILIEN GAUTHIER; ALBÉRIC BOIVIN, B.Sc.Ap.; M.-LOUIS CARRIER, I.C.; GEO.-E. GAGNÉ; CHARLES-A. GIROUX; LLOYD MCWILLIAMS, EL.E.; OSCAR VILLENEUVE, I.F.

WINDSOR CENTRE

President—CYRIL B. HALLAM, B.A.
Vice-President—D. C. BAWTENHEIMER
Past President—C. H. MONTROSE, B.Sc.
Treasurer—CHARLES A. BELL, B.A.
Secretary—RUSSELL WARWICK, B.A., 1587 Moy Ave., Windsor, Ont.
Council—MRS. MARGARET BACK; JUDGE J. J. COUGHLIN; E. J. EDWARDS; JACK EVZOVITCH, B.S.E.E.; W. ALMON HARE, B.A.Sc.; F. W. C. JONES; E. M. KREBSER; GREGORY RAWLINGS, B.A.; W. A. ROBERSON; LORNE R. ROGERS, B.A.; G. F. SPEACKLIN; GORDON E. TURNER.